AN EXPERIMENTAL STUDY OF THE EFFECT OF LANGUAGE ON THE REPRODUCTION OF VISUALLY PERCEIVED FORM

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I

History and Introduction

The experiments reported in this paper are part of a study of the conditions which affect the reproduction of visually perceived form. Previous investigators such as G. E. Müller,[1] F. Wulf,[2] and J. J. Gibson [3] have pointed out various factors which are important in bringing about the changes that occur in reproduced forms when they are compared with the forms as originally presented.

In the present study an effort has been made to control by experimental means the nature of the change in form. The directive agency used was language, or, more precisely, those processes of the organism that are initiated by language.

Historically, Müller treats of the changes that take place after the passage of time in the reproduction of perceived forms in terms which include such concepts as 'convergence' or 'blurring' of the characteristic features of patterns.[4]

F. Wulf criticizes this view and proposes, on the basis of experimental study, to describe the observed changes in terms of such specific tendencies as 'sharpening,' 'levelling' and what may be termed the 'equilibrium tendency' in the structure. He remarks, however, that in some instances his subjects spontaneously identified the presented forms with

[1] Müller, G. E., Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes, III. Teil, *Zeitschrift für Psychologie*, Ergänzungsband, 1913, 8, 1–567.

[2] Wulf, F., Über die Veränderung von Vorstellungen (Gedächtnis und Gestalt) (Beiträge zur Psychologie der Gestalt), *Psychologische Forschung*, 1921, 1, 333–373.

[3] Gibson, J. J., The reproduction of visually perceived forms, *J. Exper. Psychol.*, 1929, 12, 1–39.

[4] Müller, *op. cit.*, pp. 505 ff.

different phenomenal objects. This identification, at least in his report of the experiments, involves the *linguistic* naming of the objects, and this naming appears to have been important in the production of the reproduced forms.[5]

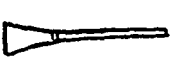
Gibson, in a more elaborate experimental study of the problem, confirms in certain respects the work of Wulf, although he carries the analysis of factors in the reproduced forms beyond the point reached by Wulf. Gibson asserts that visual forms are often changed to agree with familiar objects that have 'previously been associated with the figure in consciousness.'[6] He also alleges that a change occurring in reproduction seems often to be determined by 'cues from a verbal analysis which was made of the forms during perception.'[7] He adds, "In general, the nature of a change found in the reproduction depends upon the manner in which the figure was apprehended," for example as 'irregular' and 'Gothic' in appearance.[8] These conclusions were based by Gibson upon the result of a study of the drawings and introspective reports of subjects who had perceived certain visual patterns used in his investigation. In Gibson's study no special experimental determination by language of the nature of these perceptions was attempted.

II

Specific Problem and Methods of Experimentation

In the investigation here reported an effort was made to direct experimentally the changes in the reproduction of visually perceived form by the use of language. One set of twelve relatively ambiguous figures was prepared. (See Chart I.) Two names were assigned to each of these figures (Word List I and Word List II). The same visual figure was presented to all subjects, but one list of names was given to the figures when they were presented to one group of subjects, and the other list of names was given to the figures when they were presented to a second group of subjects. A small

[5] Wulf, *op. cit.*, pp. 347 ff.
[6] Gibson, *op. cit.*, p. 39.
[7] Ibid.
[8] Gibson, *op. cit.*, p. 16 f., and p. 36.

WORD LIST - I	STIMULUS FIGURES	WORD LIST - II
CURTAINS IN A WINDOW		DIAMOND IN A RECTANGLE
BOTTLE		STIRRUP
CRESCENT MOON		LETTER "C"
BEE HIVE		HAT
EYE GLASSES		DUMBBELLS
SEVEN		FOUR
SHIP'S WHEEL		SUN
HOUR GLASS		TABLE
KIDNEY BEAN		CANOE
PINE TREE		TROWEL
GUN		BROOM
TWO		EIGHT

control group was also used to whom the forms were presented without the assignment of any name.

The apparatus used in presenting the visual forms was a modification of the Ranschburg memory apparatus, similar to that described by Gibson.[9] The twelve stimulus-figures were drawn in black upon a white cardboard disk 19 cm in diameter. The disk was divided into 30 sectors and a figure was drawn upon every other sector. At the end of the series a space of 7 empty sectors occurred before the series repeated itself. The exposure apparatus was operated by an electrically activated pendulum. The experimenter sat at one side of the table on which the apparatus was placed, and the subject at the other side, where he could conveniently see the exposure apparatus.

By twice listening to the reading of a set of directions, the subjects were first informed that they would be shown a set of figures, and that they were to reproduce them, after the series was over, as accurately as possible, but in any order.

In any given experimental setting the apparatus was then started, and while an empty space was shown in the window of the Ranschburg apparatus, the experimenter said, "The next figure resembles . . . ." (giving one of the two names of the figure next to appear). These names were divided into two lists, I and II, respectively, as shown in Fig. 1.

As noted above, after each presentation of the total list of figures the subject was required to reproduce as accurately as possible all of the figures that he had just seen. If a recognizable representation of each figure was not given, the list was then shown again. This was repeated until a recognizable reproduction of all twelve figures was secured. The number of trials required was between 2 and 8, with an average of 3 trials. The small control group working without names required an average of 4 trials. Any verbal report volunteered by the subject in response to the question, "Will you tell me how you performed this task?" was noted down.

List I was given to 48 subjects, and List II to 38 subjects. As a check upon the naming procedure as already noted, the

[9] Ibid., p. 6.

series of visual forms was presented without names, that is, according to Gibson's technique, to 9 subjects. All subjects were college students or college teachers. Sixty of the subjects were women and 35 men. The sexes were approximately evenly divided between the two experimental groups. Altogether 3576 presentations of separate figures were given, and of this number 3051 were reproduced.

III

Results

After the experimental work had been completed, the papers on which the figures were drawn were studied, without consultation, by two of the authors. The figures were then independently rated upon the following five-degree rating scale:

Quality Step 1.—This group included all figures that were normal or approximately perfectly reproduced.

Quality Step 2.—This group included all figures with very slight changes from the original. Here were included figures which merely showed slight shortening or lengthening of lines, slight changes in curves or angles, or slight changes in the proportion of one part of the figure in relation to some other part of the figure.

Quality Step 3.—This group included all figures showing a noticeable change in the original figure, but which did not mark a complete distortion. Here were included figures showing a rather marked lengthening or shortening of lines, a clearly noticeable change in curves or angles, or a noticeable change in proportion. These figures were in all cases, however, still quite satisfactory reproductions of the original.

Quality Step 4.—This group included all figures showing marked changes such as additions or omissions, and marked changes in proportion. The figures in this group, while still somewhat resembling the original, were changed considerably from it.

Quality Step 5.—This group included figures which were almost completely changed from the original. Here were included inverted figures, and those hardly recognizable in relation to the stimulus-figure.

The basis of rating is inadequately described in the brief verbal description given above. An absolute alteration or addition in measured line might cause one figure to be put in Group 2, while a simpler change would cause it to be put in Group 3 or even in Group 4. Thus an added line in the 'sun' or 'ship's wheel' figure was much less important than an added line in the letter 'C' or 'crescent moon' figure. The rating was done independently, and at the time of rating no reference was made to the particular associated word that had been given with the stimulus-form in question. When the judgment of the two raters differed the reasons were discussed, and if a conclusion could not be reached the choice of a third judge, who was also familiar with the rating scale, was accepted. There were very few of these contested decisions.[10] The numerical result of this rating procedure is shown in Table I which presents the numbers of reproductions falling in each of the five quality steps noted above.

TABLE I

Group	Number of Reproductions
1	26
2	285
3	1011
4	1268
5	905

[10] The authors are aware of the intrinsic shortcomings of all qualitative rating schemes, and of the fact that the rating procedures employed in this experiment are theoretically open to improvement. The plan of rating used here seemed, however, to be the best device available because of the nature of the data. It can be asserted that those concerned in the experiment felt a greater satisfaction in the result of this rating after it had been performed than had been anticipated before the rating was done. It may be pointed out that the method here used, in spite of all its shortcomings, is less dependent upon one personal opinion than that used in any of the earlier studies noted in the historical introduction to this paper. There are, of course, many methods for attempting to quantify roughly a qualitative series by rating. A number of these methods are dependent upon the training of the one who is to do the rating. This is notably true in much mental testing as, for example, in the Binet-Simon 'Ball and Field' test (*Cf.* Terman, L. M., *The Measurement of Intelligence*, p. 211). In this test there is seldom any difference in opinion in regard to the type of performance of the test when the rating is done by experienced examiners. Much of the success of rating depends upon the suitable training of the 'raters' and the possibility of immediately comparing the item under consideration in a qualitative series. These two conditions were met in the present experiment (*Cf.* Dearborn, W. F., *Intelligence Tests*, pp. 8 f, and Munroe, W. S., *An Introduction to the Theory of Educational Measurement*, pp. 133–144).

For the purposes of the present study it was decided first to study the figures in Group 5, for these figures by definition showed the greatest amount of change from the stimulus-figure. Subsequent study, not recorded here, of Quality Groups 2, 3, and 4 showed similar relationships but in a less marked degree. It seemed to the present authors that if most of the figures in Quality Group 5 could be shown to have varied from the stimulus-figure without showing any constant relationship to the typical form of the objects represented by the concomitantly presented word of either list, then the conclusion must be accepted that the associated verbal stimulus was unimportant in the modification of form as shown in the reproduction of visual pattern. On the other hand, if the figure in Quality Group 5 appeared more like the object represented by the concomitantly presented word, the assumption of the influence of language would be justified. The observation of this relationship should also throw some light upon the question left unsolved by Gibson as to whether the changes that he observed were caused by the influence of past experience upon the perception or memory of form, or whether evidence can be found that unequivocally shows that the changes were caused, as alleged by Wulf, by the nature of the *structure* of the perceived form itself.

A study of the nature of the variations in Group 5 showed marked differences between different figures. These differences again required rating, which was carried out as before. In Table II the judged amount of influence of the two lists is given. It thus appears that of the 905 figures in Group 5 approximately 74 percent were like what may be termed *the visual representation of the figure named* in List I, and 73 percent were like the visual representation of the figure named in List II. A comparatively few cases of the control group to whom no verbal associate was given showed a resemblance to the visual representation of either of the named figures, or only 45 percent. Chart II shows some selected examples of pronounced modification.

It may be seen by an inspection of Table II that all of the figures were not truly ambiguous to the various subjects. It

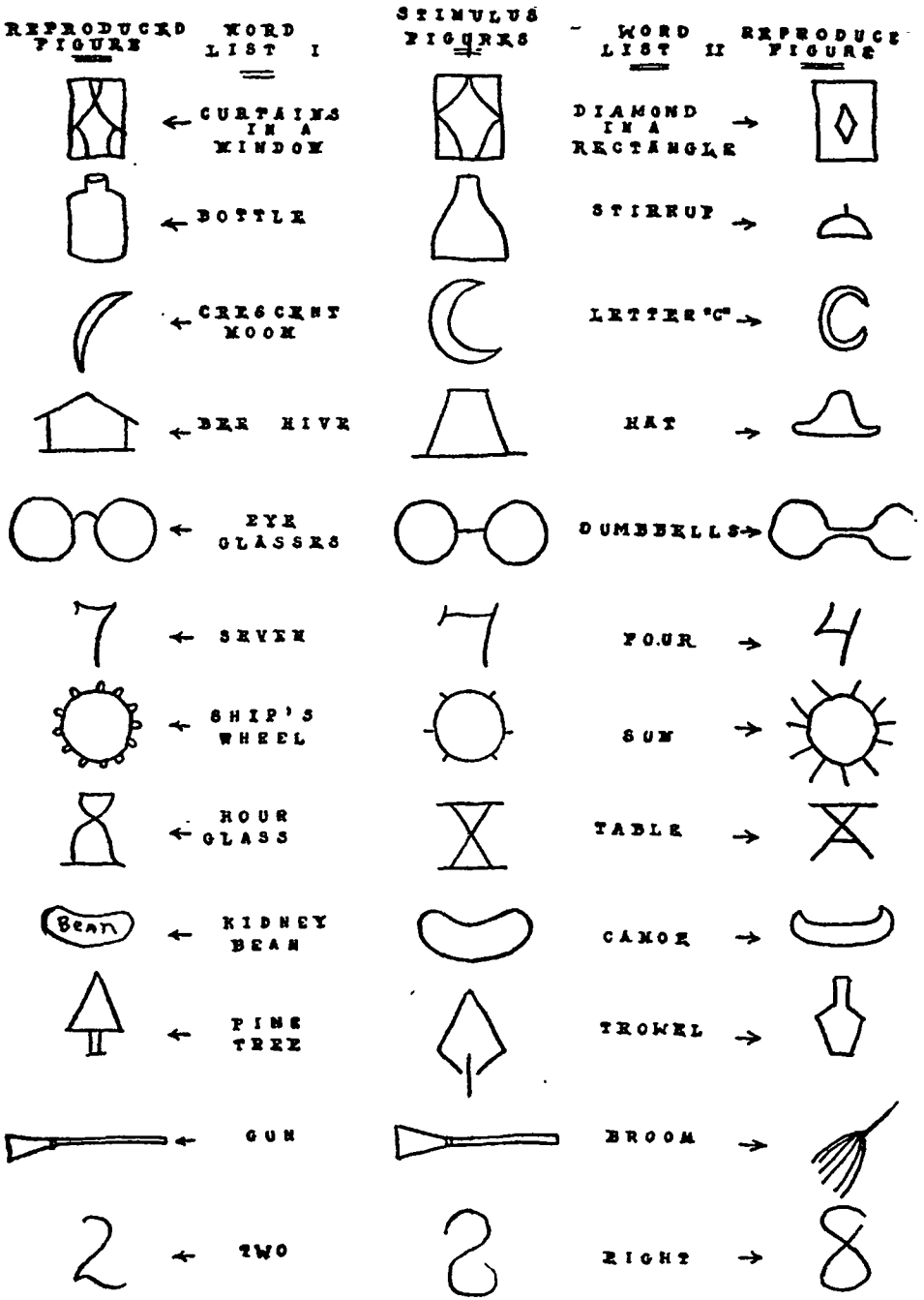

REPRODUCED FIGURE
WORD LIST I
STIMULUS FIGURES
WORD LIST II
REPRODUCED FIGURE
CURTAINS IN A WINDOW
BOTTLE
CRESCENT MOON
BEE HIVE
EYE GLASSES
SEVEN
SHIP'S WHEEL
HOUR GLASS
Bean
KIDNEY BEAN
PINE TREE
GUN
TWO
DIAMOND IN A RECTANGLE
STIRRUP
LETTER "C"
HAT
DUMBBELLS
FOUR
SUN
TABLE
CANOE
TROWEL
BROOM
EIGHT

TABLE II

Figure	Percent like Figure Named List I	List II
1	47	78
2	100	69
3	65	48
4	69	75
5	45	81
6	87	94
7	54	47
8	83	100
19	90	63
10	86	100
11	76	85
12	87	40
Total percent	74	73

may be that some verbal names were therefore much more effective than others. In some cases, even if the subjects were representing the object named rather than the form visually perceived, there would be little differentiation in the end result. The 'stirrup' and 'bottle' figure was an example of such a case. If the experiments are repeated, every effort should be made to avoid figure-name constellations of the sort represented by the stirrup-bottle figure.

In spite of these difficulties which were exposed in the course of experimentation, and in spite of the fundamental objections to the rating procedures employed in the experiment, it seems to the authors, on the basis of the examination of the forms in Groups 2, 3, and 4, as well as those considered above, that it may be said with assurance that naming a form immediately before it is visually presented may in many cases change the manner in which it will be reproduced. Besides the major conclusions just noted, the results of the experiment in many ways confirm the conclusions already published by Gibson, and in certain minor respects differ from these conclusions.

Contrary to the assertion of Wulf and Gibson, it was found in certain instances that straight lines were reproduced as curved. An example of this fact is seen in the 'table' and 'hour-glass' figure. In several instances this 'straightline' figure was reproduced in curved lines. Many examples of what Gibson terms 'figure assimilation' were observed.

In final conclusion, therefore, it may be said that the present experiment tends to confirm the observations of previous experimenters in this field, and to show that, to some extent at least, the reproduction of forms may be determined by the nature of words presented orally to subjects at the time that they are first perceiving specific visual forms.

IV

Theoretical Conclusions

The explanations offered by the previous investigators in this field to account for the observed changes in the figures have differed.

Müller, from the fundamental standpoint of his particular form of associationistic psychology, has *described* the changes that occur in reproduction in terms of certain verbal principles. But behind these descriptive terms may be discovered the intention of offering, as for example in the concept of 'affective change,' [11] an explanation of the psychological origin of the observed experience.

Wulf, on the other hand, from the standpoint of Gestalt psychology,—It will be remembered that his experiment was entitled 'A Contribution to the Psychology of Gestalt.'—turns from the older and, in one sense at least, explanatory psychology of associationism, to a more purely descriptive psychology. The changes that he treats are included under the heading '*der Gesetz der Pregnance*.' [12] According to this view all patterns tend to become 'as good as possible.' That is, they tend to achieve a greater stability and precision.[13] Köhler contends, in dealing with memorial traces, that "traces are not rigid, then; there are definite dynamical tendencies in them." [14] Köhler further, in commenting on Wulf's experiment, says in regard to reproduction, "The figures had not simply lost details at the time of graphic reproduction. The changes were much more interesting since they showed two

[11] Müller, *op. cit.*, p. 377 ff.

[12] Köhler, W., *Die physischen Gestalten in Ruhe und im stationären Zustand*, p. 259.

[13] *Cf.* Ogden, R., *Psychology in Education*, p. 238.

[14] Köhler, W., *Gestalt Psychology*, p. 309.

opposite directions: In reproduction the figures were either more regular than the original ones, or some traits which might be taken as characteristic of their organization were considerably exaggerated in the drawings. . . . Therefore, in both cases the change seemed to produce an approach toward something like an extreme type or the ideal of the first organization." [15] No explanation of this process is given, however, save that it is somehow inherent in the structure. In this case, as Gibson well says on the basis of Rignano's criticism, Wulf is evidently not speaking of physical form, but of phenomenal or conceptual form.[16] According to the Gestalt psychologist, then, a configuration is dynamic and is governed by the laws of its own structure. Gibson points out, "The issue is this: Is the change in the reproduction of a perceived form caused by the influence of past perceptions on the perception and memory of this form, or is the change caused by the nature of the form itself? No attempt is made to solve this issue." [17]

It may now be seen that the experiments in this paper were set to bear directly on this problem. In the view of the present authors, the experiments here reported tend to substantiate the view that not the visual form alone, but the method of its apprehension by the subject determines, at least in certain cases, the nature of its reproduction.

It is the belief of the present authors that psychology is not yet in a position to *explain* this process of apprehension with assurance. As Wulf himself points out,[18] Wundt's concept of assimilative perception might be used as an explanatory principle. Similarly, the results can be explained in

[15] Ibid., p. 310.

[16] Gibson, *op. cit.*, p. 34; Rignano, E., The psychological theory of form, *Psychol. Rev.*, 1928, 35, p. 128.

[17] Gibson, *op. cit.*, p. 35. Dr. Gibson informs me in a private communication that Dr. Koffka, under whose direction the article by Dr. Wulf was written, would prefer, instead of the phrase 'change caused by the nature of the form itself', some statement emphasizing the fact that in his opinion the change was caused by dynamic processes within the physiological correlate of the percept. The writers wish to thank Dr. Gibson for making this suggestion and for other suggestions which have been incorporated in this paper.

[18] Wulf, *op. cit.*, p. 367.

terms of the Herbaritian apperception,[19] and, to choose but a single additional example, by Witmer's pre-perception.[20]

A so-called 'dynamic view' is favored by Gibson. This view holds that assimilation in perception is not caused by a fusion of images, nor yet by the influence of one configuration upon another, but by the turning of a new perceptual process into earlier channels of perceptual activity.[21] This view is not unlike, in certain respects, the engram theory of Semon, if that theory were to be applied to the present problem.[22]

To the present writers such theories seem interesting and important but possibly premature. Further experimental work in terms of careful introspection must be done if the exact nature of the processes of apprehension, reproduction, and recognition as seen in this experiment, are to be understood. On the basis of introspective reports secured in the present experiment, it seems probable that great individual differences will present themselves. In science, in general, a complete description can only be given when all of the terms of the so-called 'causal' series are known. When the theoretical psychologist is forced to jump from the stimulus object to the result of objective response, namely, in this case, the reproduced drawing, error is likely to creep in. A suggestion of some of the stages which may lie between these two extremes may be presented here. It should be understood, however, that this attempt is given in the most tentative terms.

1. When a meaningful word is heard by an individual, some process within his organism is initiated which presumably includes receptor activity, neural activity, and effector response. This activity includes the activity of those processes which are held by some psychologists to be the correlates of the introspectively known states of imagery or symbolic representation. These physiological processes are, if the

[19] Boring, E. G., *A History of Experimental Psychology*, p. 245.

[20] *Cf.* "A perception may be determined by the association of an anticipating mental image or idea of the object,—*i.e.*, by pre-perception." Witmer, L., *Analytical Psychology*, p. 4.

[21] Gibson, *op. cit.*, p. 38.

[22] Semon, R., *Mnemic Psychology*, pp. 169–197.

theory be accepted, in part the result of present sensory stimulation, and in part the result of the eduction [23] of activities and experiences that would not be as they are save for the past experience of the organism.

2. When a visual (or, indeed, any other sensory) pattern is perceived by an individual, it may likewise be assumed that certain processes within the organism are initiated which include activities similar to those considered above, but which are in some measure correlated with the given visual experiences.

3. The present objective experimental results seem to show that in many cases the recall of a visually perceived form is altered by the fact that a particular word is said immediately before the visual presentation of the form.

4. Without the use of additional terms, therefore, it seems that if a subject has just heard, for example, the word 'eye glass,' certain processes in his organism have been started that initiate certain processes which are possible because of the past experience of that individual with *eye glasses* as words and as objects. If, while these processes are in progress, a figure of two visual circles connected by a line is presented to the subject, this figure may later be reproduced in a different manner than as if the processes present in the individual at the time of the same visual presentation had been evoked by the word 'dumbbell.' In other words, without recourse to any elaborate theory, one who wishes to make an empirical statement of fact may say: If a verbal stimulus-form and a visual stimulus-form are presented to a subject in certain temporal relationships, the processes in question may be modified, or rather a new total process may result, which is in certain respects unlike either of the previous sets of processes. On subsequent arousal by any 'part' stimulus the 'reproduction' is thus a complexly determined total, and not either of its component processes.[24]

[23] *Cf.* Spearman, C., *The Nature of Intelligence and the Principles of Cognition*, pp. 70 f.

[24] *Cf.* Hollingworth, H. L., *Psychology: Its Facts and Principles*, pp. 33–49, for a treatment of the general laws of redintegration.

Thus, as is so often the case, phenomena that are said to be explained in the verbal terms of the Configurational theory may at least tentatively be described in terms of a dynamically considered process of association.[25]

[25] For an outline statement of this view see Warren, H. C., and Carmichael, L., *Elements of Human Psychology*, pp. 176–184.

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